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PRACTICAL RESULTS IN BASKET WILLOW CULTURE.

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This circular gives the results of two years' tests in the United States of growing standard European basket willows under different methods of management. The tests have all been made since the publication of Forest Service Bulletin 46, The Basket Willow, which dealt fully with the general subject of willow culture. The investigation of basket willow undertaken by the Forest Service was to enable willow growers in this country to compete successfully with the European product, and it has shown that, by careful and proper management and by the selection of certain strains, American growers can produce a stock equal or even superior to the best imported.

THE EXPERIMENTAL HOLT.

The willow holt of the Forest Service is on the experimental farm of the Department of Agriculture, at Arlington, Va., on rather low, moist bottom land of the Potomac River, with a sandy loam soil underlain by a loamy clay subsoil; it remains moist through the year. Flood water from the river comes within a few yards of the holt, but does not inundate the area during the growing season.

The willows tested are those most commonly grown in this country: Welsh or purple, Lemley, patent Lemley, and American green or almond. Their characteristics and requirements are described in Forest Service Bulletin 46.

ESSENTIAL PROPERTIES OF HIGH-CLASS RODS.

Basket willows intended to be used with the bark on must be smooth, tough, flexible, branchless, and cylindrical, and the color of the bark must remain a light brown. Those to be used in the peeled state must have the same general characteristics and must remain white in color when peeled. In addition to these qualities, the rods must have small pith and straight grain in order to bring the highest market price.

PRACTICAL RESULTS OF THE EXPERIMENTS.

Tests were made on two phases of willow culture—spacing and cutting; for the results from close, medium, and wide spacing, and from high or low cutting. During the progress of the experiments there was a constant demand by willow growers for stock from the Forest Service holt. This demand was supplied very largely from the close-spaced plats, since they contained the best rods. As a consequence the results from the 6-inch by 18-inch plantings are not as accurate as they should be, because they were based on insufficient data, and in some cases they are altogether omitted. The experiments have brought out these facts:

1. Wide spacing greatly decreases the number and total weight of rods for a given area and increases the weight of individual rods.
2. Spacing has little effect on the length of the best rods, but wide spacing lowers the production of unbranched rods.
3. Close spacing greatly retards the growth of weeds.
4. Spacing has little effect on the proportion of bark to wood.
5. Cutting below the surface of the ground lowers the quality of the rods.
6. Cutting below the surface of the ground decreases the productivity of the stools.

An additional investigation demonstrated the value of willow bark as a source of tannin.

THE EFFECTS OF SPACING.

The willows in the holt at Arlington were carefully studied for a solution of the spacing problem. The cuttings were set by three systems: 6 inches apart in the row, with 18 inches between the rows; 9 inches apart with 21 inches between the rows, and 12 by 36 inches. The form and quality of rods produced under these spacings show the decided disadvantage of wide planting. For instance, Lemley and patent Lemley yield considerably less shoots per unit area in wide spacing, and the latter also a consequent smaller total production by weight, though the average rod is heavier.

TABLE 1.—*Effect of spacing on yield per square rod, by number and weight.*

Varieties.	Spacing.								
	Close—6 by 18 inches.			Medium—9 by 21 inches.			Wide—12 by 36 inches.		
	Quantity.	Weight.	Weight per rod.	Quantity.	Weight.	Weight per rod.	Quantity.	Weight.	Weight per rod.
	Number.	*Pounds.*	*Pounds.*	*Number.*	*Pounds.*	*Pounds.*	*Number.*	*Pounds.*	*Pounds.*
Lemley	549	49.2	0.089	1,272	141.5	0.111	504	90.3	0.179
Patent Lemley	423	98.3	.208	709	98.5	.124	369	52.4	.142

The figures collected during the two years of experiments not only demonstrate that wide spacing increases the percentage of branched

rods over medium spacing, but that the rods in the wide-spaced plats are as a rule less straight and flexible and less cylindrical than in close or medium spacing.

TABLE 2.—*Effect of spacing on the branching of rods, in per cent of total yield.*

Varieties.	Spacing.					
	6 by 18 inches.		9 by 21 inches.		12 by 36 inches.	
	Branched.	Unbranched.	Branched.	Unbranched.	Branched.	Unbranched.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Lemley	35	65	13	87	25	75
Patent Lemley	35	65	23	77	34	66
American green	26	74	19	81	23	77

Height growth is not much affected by spacing. Height measurements were taken every twenty days from May 15 until the end of the growing season. The figures in Table 3 do not show the average length of all rods in the plats, but the average length of only the longest or choice rods, which are about 20 per cent of the whole.

TABLE 3.—*Effect of spacing on height growth.*

Time measured.	Welsh.			Lemley.		
	Spacing, 6 by 18 inches.	Spacing, 9 by 21 inches.	Spacing, 12 by 36 inches.	Spacing, 6 by 18 inches.	Spacing, 9 by 21 inches.	Spacing, 12 by 36 inches.
	Height. Ft. in.	*Height. Ft. in.*	*Height. Ft. in.*	*Height. Ft. in.*	*Height. Ft. in.*	*Height. Ft. in.*
May 15	1 6	1 6	1 6	1 6	1 3	1 0
June 5	3 2	3 6	3 6	2 6	1 3	1 0
June 25	4 4	4 6	5 0	3 9	3 9	4 0
July 15	5 8	5 5	6 0	5 0	5 0	5 0
August 5	6 2	6 0	6 6	6 0	5 9	6 0
End of season	6 2	6 0	6 6	6 9	6 6	6 6

Time measured.	Patent Lemley.			American Green.		
	Spacing, 6 by 18 inches.	Spacing, 9 by 21 inches.	Spacing, 12 by 36 inches.	Spacing, 6 by 18 inches.	Spacing, 9 by 21 inches.	Spacing, 12 by 36 inches.
	Height. Ft. in.	*Height. Ft. in.*	*Height. Ft. in.*	*Height. Ft. in.*	*Height. Ft. in.*	*Height. Ft. in.*
May 15	2 0	1 6	1 6	2 0	2 3	2 0
June 5	2 6	2 6	2 6	3 9	4 0	3 6
June 25	3 0	3 6	3 0	4 9	5 0	5 0
July 15	5 6	6 0	6 0	7 0	7 0	6 6
August 5	6 0	6 6	6 6	7 9	7 9	7 6
End of season	6 6	7 0	7 0	8 3	8 3	8 0

SUPPRESSION OF WEEDS.

Experiments in the Arlington holt clearly show that close spacing almost completely shades out weeds. This is less true of Welsh, however, than of the other three varieties, which have broader leaves, which more completely shade the ground. Since a large proportion of the willow holts of this country are sooner or later abandoned because they become overrun by weeds, it seems important to emphasize the

advantages of a system of planting which will remedy this evil and thus prove the key to successful willow culture. The three broad-leafed species under close spacing completely shade the soil and keep it moist and loose during the entire growing season. Crown cover is relatively small during the first two years of the life of the holt, and the rank growth of weeds that is likely to spring up must be carefully kept down. This will necessitate at least three thorough hoeings during each season. After the second year the growth of the willows themselves is sufficient to shade out weeds, and only one weeding or hoeing in the early spring may be necessary. It is especially recommended that small-leafed varieties, such as the Welsh, be planted 6 by 18 inches apart, and though it is seldom advisable to plant closer than this, it may be done in very rich soil where weeds are especially troublesome. Also it is advisable to plant dense foliage varieties with those in which the leaf development is insufficient to shade the ground. This practice is highly recommended by European growers. Just what broad-leafed kinds are best for mixture with Welsh and other narrow-leafed varieties under American conditions will be determined later from mixed plantations already under cultivation by the Forest Service.

AMOUNT OF BARK.

Heretofore the proportion of bark has not been considered, except as an excess of bark in the total weight meant a lessened weight of peeled rods. It has been found in long practice that the dried peeled rods weigh about one-third as much as the green rods with the bark on, and also that the best grade of rods has the smallest proportion of bark. But since it has been discovered that the bark of some varieties has a large per cent of tannin and should find a ready market as tanning material, the proportion of bark, as affecting the value of the crop, becomes relatively unimportant, especially as the experiments have shown that spacing evidently has little effect upon the proportion of bark, and that between 40 and 45 per cent of the green weight of average stock is always lost by peeling. Table 4 shows the variations of weight of bark for medium and wide spacing, and Table 5 shows the percentage of bark according to grades.

TABLE 4.—*Weight of bark in per cent of total green weight for medium and wide spacing.*

Varieties.	Spacing.	
	9 by 21 inches.	12 by 36 inches.
	Per cent.	*Per cent.*
Welsh	40.1	43.9
Lemley	42.5	44.9
Patent Lemley	43.5	41.6
American green	42.4	46.6

TABLE 5.—*Per cent of bark to total weight according to grades.*

Grade.	Welsh.	Lemley.	Patent Lemley.	American green.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
1	41.0	40.7	35.6	40.5
2	43.9	41.4	42.3	44.3
3	54.2	44.9	40.3	56.0
4	----------	54.7	64.0	----------

THE EFFECTS OF CUTTING.

There is no part of willow growing so much under discussion as the question of low cutting. The reason chiefly urged for cutting the rods well below the surface of the soil is that it prevents the attack of insects and fungous diseases in the stools. Yet, too close cutting results in the production of brittle rods, while the greater exposure of cut surface frequently causes dry rot in the stools and impairs their productiveness.

During the spring of 1906 part of the stools were cut as low as possible, in order to determine the result. Where the rods were cut off below the surface of the soil the new shoots, forced to issue from dormant or adventitious buds of the wood older than that of the basal part of the rods, were extremely brittle. Another cause of brittleness of the rods, which greatly lowers the value of the crop, is due to the fact that the root systems of such closely cut stools have been developed sufficiently to support double the number of shoots; in consequence the few shoots produced receive a superabundance of nourishment and make such vigorous and rapid growth that they become brittle and develop many side branches. Further, the fact that the growing surface is so reduced that only a few shoots can grow from it results in a short crop. A number of cases have been observed where stools that were cut too low died within a single season after cutting. Table 6 compares the yield in 1906 with that of the following season, when the crop was produced on stools which had been cut too close. Besides the difference in the crops of the two years there is also shown a marked advantage of the medium over the wide spacing.

TABLE 6.—*Comparison of crops from moderately low and excessively low cuttings, in pounds per square rod.*

Varieties.	Spacing.			
	9 by 21 inches.		12 by 36 inches.	
	1906.	1907.	1906.	1907.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Welsh	90	29	94.5	20
Lemley	141.5	80	90.3	28
Patent Lemley	98.5	62	52	32

Still another point against the European practice of low cutting, and entirely aside from the results, is the difficulty connected with it. From the very nature of growth, the stools tend to become high, and climate, soil, moisture, spacing, variety, and the manner of harvesting the crop, all contribute to this tendency and against the practice of cutting below the surface. The stool of the Welsh variety spreads out rather than increases in height, and therefore may be kept fairly low, but the Lemley, patent Lemley, and American green have their "eyes," or buds, far apart, and as a rule higher stubs must be left, in order to insure a sufficient number of shoots from the preceding year's growth.

In this climate, especially in wet soils where all varieties have shallow root systems, the stools are likely to be heaved out every winter by frost.

POSSIBLE USES OF WILLOW BARK.

The bark of the peeled stock has usually been considered worthless by willow growers and is generally thrown away. Experiments were undertaken by the Forest Service to find the best way to utilize this waste. Large samples of bark from all the willows on the experimental farm were analyzed by the Bureau of Chemistry of the Department of Agriculture in order to determine the percentage of tannin available in the bark of each variety. It had long been known that willow bark contained tannin, but so far as can be discovered the actual amount available, especially from basket willows, had not been determined in this country. The tannin content was found to be comparatively large; yet it has never been turned to economic use, although the analyses show that these barks contain sufficiently large quantities of tannin to make them valuable in the leather industry. The amounts are as follows, by varieties:

	Per cent.
Welsh	8.75
Lemley	6.98
Patent Lemley	6.41
American green	11.38

Welsh yields approximately a ton of dry bark per acre, while American green, which contains a still higher percentage of tannin, yields a much greater quantity.

In other countries the bark is used for several purposes; it is manufactured into door mats which outlast those made of straw or rushes, and in parts of France, where the bark is used for fodder and for bedding for cattle, it sells for $15 per ton. The bast of all the varieties of basket willow has been used recently in weaving a coarse cloth from which sacks are made.

MARKETING THE PRODUCT.

Inquiries concerning the market for basket willow rods are constantly received from persons who are considering the establishment of holts. Good rods of almost any variety can be sold, but some basket makers may have need of special varieties or grades, which can be grown with especial profit. Since many local growers find it convenient to sell their stock to near-by manufacturers, it is advisable, before planting, to ascertain from possible purchasers what stock they demand. Values vary, of course, in different parts of the country, and the proximity or remoteness of markets must be considered. So far the industry has been developed only locally, and for this reason the large markets are generally near the centers of production; yet there are basket and willow-furniture factories in nearly all the large cities. Makers of the best grades of baskets and furniture are particularly eager to get high-class stock in this country, for they thereby save the import duty on the kind of rods that are generally obtainable only from abroad. For this sort of material good prices prevail.

In preparing stock for market, the rods should be very carefully sorted, according to length, into four or five grades. The rods should be tied securely in bundles and then carefully crated, to prevent the breaking off of the top ends of the rods.

Upon application, the Forest Service, Washington, D. C., will furnish to willow growers the names and location of the manufacturers of willow ware nearest to them.

Approved:

JAMES WILSON, *Secretary.*

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